

# **SEDAR**

## ***SouthEast Data, Assessment, and Review***

### **Consolidated SEDAR Workshop Recommendations for Research, Monitoring, and SEDAR Procedures**

**May 12, 2005**

**SEDAR  
One Southpark Circle # 306  
Charleston SC 29407**



## **PREFACE**

This document is a compilation of the research, monitoring, and procedural recommendations provided by SEDAR workshop panels. It is intended to provide a single-source reference for those interested in conducting research and improving monitoring. It is also intended to enhance future SEDAR stock assessments by highlighting areas identified as needing improvement in previous assessments.

Items are presented as provided in SEDAR reports with only minor editing where necessary for clarification or to reduce duplication. Prioritizations are noted and preserved for those instances where recommendations were prioritized.

Each SEDAR project is listed in a separate heading within which recommendations are listed by workshop (e.g., data, assessment, and review). Research and monitoring recommendations are listed separately from process recommendations. Recommendations of the independent experts provided through the CIE (Center for Independent Experts) are listed separately from the workshop panel recommendations.



## *Table of Contents*

I. SEDAR 1 South Atlantic Red Porgy .....	7
A. Assessment Workshop .....	7
B. Review Workshop .....	8
C. CIE Consultant Recommendations .....	9
II. SEDAR 2: South Atlantic Black Sea Bass and Vermillion Snapper .....	11
A. Black Sea Bass Assessment Workshop .....	11
B. Black Sea Bass Review Workshop .....	11
C. Vermillion Snapper Assessment Workshop.....	12
D. Vermillion Snapper Review Workshop .....	13
E. Review Workshop Recommendations applicable to both assessments .....	14
F. CIE Consultant Recommendations (applicable to black sea bass and vermillion snapper) .	15
III. SEDAR 3: South Atlantic/Gulf of Mexico Yellowtail Snapper .....	17
A. Assessment Workshop .....	17
B. Review Workshop .....	17
IV. SEDAR 3: ASMFC Atlantic Croaker and Menhaden .....	21
A. Atlantic Menhaden Research Recommendations .....	21
B. Atlantic Croaker Research Recommendations.....	22
V. SEDAR 4: South Atlantic Snowy Grouper and Tilefish.....	25
A. Tilefish .....	25
B. Snowy Grouper .....	26
C. Recommendations from the Review Workshop Consensus Report.....	27
VI. SEDAR 4: Caribbean Deepwater Snapper Grouper .....	31
A. Recommendations for the collection of landings statistics.....	31
B. Recommendations for the Trip Interview Program (TIP).....	31
C. Recommendations for the estimation of catch rates.....	32
D. Recommendations for the analysis of species composition.....	33
E. Recommendations for the Caribbean SEAMAP Survey.....	33
F. General Recommendations .....	33
G. Data Workshop Conclusions on the Availability of Data for Stock Assessments.....	34
VII. SEDAR 5: Atlantic and Gulf of Mexico King Mackerel .....	39
A. Assessment Workshop Recommendations .....	39
B. Review Workshop Recommendations .....	40
C. Comments from the CIE Contractors.....	42
VIII. SEDAR 6: Goliath Grouper and Hogfish .....	45
A. Goliath Grouper .....	45
B. Hogfish .....	46
C. Comments from CIE contractors.....	47



## **I. SEDAR 1 South Atlantic Red Porgy**

### **A. Assessment Workshop**

#### **1. Research Recommendations**

- a. The discrepancy between SC and NC aging is a major need that must be resolved, preferably before the next assessment. The SAW recommends that as soon as possible, the NC and SC investigators meet and share age readings techniques, to resolve the systematic discrepancies in age determinations, if possible. The SAW further recommends that research be undertaken that will accomplish verification of aging in red porgy.
- b. The protogeny of red porgy is a life history feature that complicates assessment and management. The SAW recommends that sampling for sex ratio at length be instituted in each fishery and that population sampling for sex ratio at length be continued by the MARMAP program. The SAW further recommends that research be instituted into assessment and population-projection methods that can make better use of sex-ratio data that exist now and that may exist in the future.
- c. Under many forms of management, considerable discarding of red porgy could be expected to occur. The SAW recommends that sampling programs be initiated to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates. The SAW recommends that research be instituted on management strategies that could reduce discard mortality and also research to illustrate the effects of discard mortality. The SAW also recommends that socioeconomic research be considered on educational measures to assist fishery participants in minimizing discard mortality and understanding the value of doing so.
- d. Fishery-independent data collected by the MARMAP program have served an important role in understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment generally. However, the MARMAP sampling programs have been criticized by some as not having ideal extent, both in area coverage and in sampling intensity, for red porgy. The SAW recommends that the MARMAP program expand its coverage as needed.
- e. During the DW and SAW, it was noted that some incomplete, or misleading data have been entered in the NMFS general canvass data base. In particular, some data are available only under aggregated categories (e.g., porgies), even when accepted corrections to provide estimates of red porgy landings exist. The SAW recommends that state agencies contact and work with NMFS personnel maintaining the general canvass data base to make sure that data in that central data base are at the most disaggregated level possible and as accurate as possible. The goal is that future red porgy assessment should be able to use data from the general canvass data base with confidence and without further corrections.
- f. A hook and line index of abundance should be developed for deeper water.

- g. The aging assumptions and the plus-group assumptions in the age structured model should be evaluated.
- h. Alternative assumptions about M should be evaluated.
- i. Sampling of catch by sex from commercial vessels should be initiated.
- j. Analyses to develop indices of abundance should consider the effects of unsuccessful effort.

## B. Review Workshop

### 1. Research Recommendations

- a. Sampling for sex ratio is needed where protogeny is a concern; models and evaluations should incorporate this feature. Stock assessment scientists should discuss and develop methods to deal with these species. The implications of alternative assumptions about spawning stock definitions (total biomass, female biomass or.....) should be investigated.
- b. At-sea observers should be considered for monitoring discard and developing CPUE indices.
- c. Red porgy switch sex from females to males. The analytical tools and biological reference points do not take this into consideration. Implications of this are unknown and could have important affects on reference points and estimates of recovery.
- d. Concern was expressed that important information on the status of larger red porgy derived from deeper waters was not available as a separate index for inclusion in the assessment. It is recommended that further consideration be given to developing such indices from commercial and fishery independent data.
- e. Effective monitoring of stock recovery, especially under further fishing mortality reductions, will require information on discards.

### 2. Process Recommendations

- a. The three step process (DW, SAW & SARC) proved to be very useful. It is recommended that more time be allocated between each of these steps. It would be helpful to have this incorporated into the Terms of Reference.
- b. If more than one stock is to be assessed per year, substantial additional resources must be provided. Additional funding will be necessary for NMFS and state participants.
- c. Participation of industry was a very important part at each step of the process. This practice should be continued.
- d. Priorities as to the stocks to be assessed need to be set.
- e. Having both NMFS and state scientists participating in the decision process for input data and assumptions for the model was very useful.
- f. Input from SARC participants other than on the panel was very useful. This will facilitate exchanges between the SAW and SARC participants.
- g. As well as peer review, the SARC was a useful forum for the exchange of technology and ideas.
- h. In future, the SARC will draft the Consensus Report at the meeting with a subsequent review.

- i. Improved technical support is required; printers, copiers, hard copy of drafts, LAN and other support.

#### C. CIE Consultant Recommendations

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- Future SARCs should be larger; there was no buffer.
- More emphasis should be placed on systematic and structured comparison (figures and tables) with earlier assessments.
- The Chair was required to fill two roles; steering the meeting and as a technical reviewer.



## **II. SEDAR 2: South Atlantic Black Sea Bass and Vermillion Snapper**

### **A. Black Sea Bass Assessment Workshop**

#### **1. Research Recommendations**

- a. Representative age sampling is needed (proportional); also commercial age sampling.
- b. Increased fishery independent sampling.
- c. Development of logbook indices is recommended.
- d. Information about fecundity is needed (batch fecundity and frequency at age and/or size).
- e. Further consideration of implications of change in sex for fishery management.
- f. Further development of analytical models to incorporate historical catch information.
- g. Future research should be conducted to further develop age-structured models that could account for historic landings. Specifically, methods that allow scaling of uncertainty in landings records over time are needed. We need to include more historical records which are more uncertain than current records, this may be done by changing CVs over time as opposed to constant CV for a data series.

### **B. Black Sea Bass Review Workshop**

#### **1. Research Recommendations**

Recommendations are listed in priority order as identified by the workshop panel.

- a. The Panel requested that SC DNR expand their MARMAP efforts to conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies and thus connecting the several short MARMAP indices available for this assessment.
- b. Commercial fisheries data, including logbooks, should be analyzed to determine whether it is possible to develop a reliable fishery-dependent index of abundance from these data.
- c. The monitoring program should be expanded to collect data on the magnitude, release mortality, and the size/age composition of the black sea bass that are discarded by each fishing sector and from each fishing gear and depth.
- d. Age samples need to be increased and collected appropriately for use in aging the catches of the various fishery sectors. Furthermore, the possibility of determining reliable age compositions from the historical MARMAP age samples needs to be evaluated.
- e. The Panel suggested that a comprehensive study and documentation of the abundance index derived from the headboat data would be useful. For example, consideration might be given to whether changes in fishing operations, including species composition of landings, might reflect changes

in catchability of black sea bass that have not been taken into account by the GLM.

- f. The Panel considered that, through more detailed examination, it might be possible to develop an acceptable abundance index from the MRFSS data and suggested that this should be investigated.
- g. An index of recruitment for the stock should be developed.
- h. Research should be initiated to estimate fecundity by female size and age.
- i. The Panel considered the possibility that fish from the assemblages of black sea bass located north and south of Cape Hatteras, NC, might mix and suggested that a research study should be initiated to investigate its magnitude, geographic extent, direction, timing and management implications.
- j. The Panel recommended that the issue of whether it is more appropriate to use total mature biomass, mature female biomass or some other measure of spawning potential for a protogynous hermaphrodite should be investigated.
- k. The Panel concluded that the application of a production model should be investigated as to its appropriateness for a protogynous species.
- l. The behavioral dynamics associated with reproduction in this protogynous species should be investigated with respect to the effects of size selective harvesting.

## C. Vermillion Snapper Assessment Workshop

### 1. Research Recommendations

- a. The statistical weights assigned various data sources in the assessment model can influence the results. At present, weights are determined heuristically to provide a balance of fit to all data sources. The group recommends further research to investigate methods of weighting data sources, e. g., based on their apparent significance, relevance, or reliability.
- b. Fishery-independent data collected by the MARMAP program are used in many stock assessments in this region, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment generally. However, the MARMAP sampling programs do not have ideal extent, either in area coverage or in sampling intensity, for vermilion snapper. The group recommends that the MARMAP program expand its coverage, particularly into deeper water, as needed.
- c. Under many forms of management, considerable discarding of vermilion snapper could be expected to occur. The group recommends that sampling programs be strengthened to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates better. The group recommends that research be instituted on management strategies that could reduce discard mortality.
- d. Data have been recorded from commercial catch logbooks since 1993. However, logbook data have not been incorporated into stock assessments in the South Atlantic because of apparent difficulties in analyzing the data. The DW and AW both recommended that an investigation be undertaken to

determine the feasibility of and best methodology for using commercial logbooks to develop an abundance index for the commercial fishery for vermilion snapper. 5. An important data element for stock assessment, including vermilion snapper, is routinely collected age-composition data for major fisheries. The DW and AW recommend that regular statistical sampling and analysis of vermilion snapper for aging is needed, in both the commercial hook-and-line and headboat fisheries. A minimum sample size of 500 ages per year is recommended from each fishery.

- e. Abundance indices for vermilion snapper indicate only minor fluctuations in population abundance during the model time period. This low population contrast is partly responsible for the large uncertainty in estimates derived from the model. The AW recommends that alternative age-structured models be investigated for vermilion snapper and other low contrast populations to determine whether more robust population estimates might be achieved.
- f. Recreational landings estimates for vermilion snapper (and other species) in the MRFSS database are often highly variable, resulting in large year-to-year swings in the estimates. Those swings apparently reflect sampling error, rather than true fluctuations in fishery landings. Such large year-to-year changes can influence assessment models in undesirable ways. The AW recommends that smoothing techniques be investigated to potentially reduce some of those large year-to-year changes. This will be particularly important for other species, many of which are taken in larger fractions by the recreational fisheries sampled by MRFSS.
- g. Although an age-structured model was ultimately not used in this assessment of vermilion snapper, it was noticed when developing this model that fecundity estimates were available only by length and not by age. The AW recommends that fecundity estimates at age be developed for future use in age-structured models.

#### D. Vermillion Snapper Review Workshop

##### 1. Research Recommendations

- a. The panel proposed that MARMAP conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies. This would allow a more comprehensive fishery-independent index to be developed.
- b. Age samples from the various fishery sectors need to be increased and collected appropriately for use in stock assessment.
- c. Commercial fisheries data (including logbooks) should be analyzed to determine whether it is possible to develop a reliable fishery-dependent index of abundance from these data.
- d. MARMAP should be expanded into deeper water to assure greater representation of the spatial range of the stock.
- e. A monitoring program should be developed to collect data on the magnitude and the size/age composition of the vermilion snapper that are discarded by each fishing sector and from each fishing gear.
- f. An index of recruitment representative of the entire stock should be developed for vermilion snapper.

- g. The Panel recommended that, as an alternative model that could be applied in parallel with the existing model, consideration might be given to combining the indices of abundance externally and using the resultant combined index in the length-structured model rather than including the separate indices within the model. This suggestion was also made with respect to the black sea bass assessment. The external analysis might provide better understanding of the input data and make the weighting more transparent.

## 2. Process and Procedure Recommendations

- a. The Panel suggested that, in future assessments, consideration should be given to calculating and presenting estimates of the abundance-at-age weighted fishing mortality to supplement the information that is presented on the fishing mortality for fully-recruited fish.
- b. The estimated abundance indices used in the assessment of this stock are based on a limited spatial coverage that does not fully reflect the entire stock. In the short-term, information from the commercial fishery on the abundance of larger vermilion snapper should be examined. Over the long-term, fishery independent sampling should be expanded.
- c. Attention should also be given to developing a recruitment index.
- d. Effective monitoring of stock status will require more and improved data on discards. It is recommended that the bycatch logbook be continued and expanded estimates provided.

## E. Review Workshop Recommendations applicable to both assessments

- a. The descriptions in the assessment reports of the methods, which were used to collect and to analyze the data used in the assessments, were not sufficiently complete for a thorough and comprehensive review. Similarly, technical descriptions of the model structure, which were provided in the assessment reports, were sketchy and insufficiently complete. Accordingly, members of the Review Panel were obliged to base much of their assessment on the information provided in the verbal presentations. It is possible that the detailed descriptions that were sought by members of the Review Panel may be presented in the reports of the Data or Assessment workshops. However, if not, it is recommended that the assessment reports for future stock assessments should include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment. Generic descriptions of these methods should be developed, that are broadly applicable to this and future assessments.
- b. For future stock assessments, sufficient details of the methods of data collection should be provided to allow the Review Panel to assess the extent to which catches from different spatial or temporal zones or from different fishing sectors have been representatively sampled, how the various samples are combined, and the sampling intensity that has been applied to the different sectors. Standard errors of estimates of landings and of the various abundance indices should be calculated whenever possible, and potential sources of bias should be identified and adjusted for when feasible. It is

acknowledged that the data will be adjusted in the model for gear selectivity. In the current assessment, the Review Panel was not able to assess whether samples were representative and, if not, the likely magnitude of bias that would result.

- c. The Review Panel considered that minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by the assessment team and that sample sizes should be increased if the sampling intensity should fall below this minimum level. The sampling designs of the various data collection methods should be reviewed for statistical adequacy (sampling intensity and spatio-temporal coverage).
- d. Data should be reported in tabular as well of graphical format, to allow the Review Panel to explore miscellaneous aspects of the data.
- e. For future SEDAR reviews, the biological evidence and scientific motivation that led to the selection of the base parameter case as well as alternate parameter choices that are considered for sensitivity runs should be documented in the Assessment Report. Such selection will most likely take place at the Data Workshop, but any modifications that are made at the Assessment Workshop should also be recorded.

#### F. CIE Consultant Recommendations (applicable to black sea bass and vermillion snapper)

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- a. I strongly recommended that the assessment reports for future stock assessments include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment.
- b. Minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by during the Data and Assessment Workshops, and those sample sizes should be increased if the sampling intensity should fall below this minimum level.
- c. Over time, it is strongly recommended that the assessment assign more weight to fisheries-independent survey indices from the MARMAP program. MARMAP should also be expanded into deeper water to improve the spatial coverage of the stock.
- d. it is recommended that commercial logbook data be evaluated for inclusion as auxiliary information in stock assessments.
- e. I recommend that the variability in assessments caused by sampling variability in estimated landings in number by age be evaluated, for example by applying bootstrapping to port sampling data in connection with the model runs.
- f. The current stock assessment models for vermillion snapper and black sea bass apply a large number of parameters that are difficult to track. The external analysis of multiple survey indices of abundance might provide a better

understanding of the input data, make the weighting more transparent, and result in a more parsimonious stock assessment model.

### **III. SEDAR 3: South Atlantic/Gulf of Mexico Yellowtail Snapper**

#### **A. Assessment Workshop**

- a. As with other fisheries, we need data on all removals from the fishery.
- b. We need to collect annual discard information from all sectors of the fishery.
- c. An improvement for the assessment would be to develop a probabilistic aging procedure that accounts for selectivity and mortality that uses the catch-at-length and fishery-independent and fishery-dependent ages and lengths.
- d. We need to investigate the inclusion of interaction terms in the calculation of standardized catch rates.
- e. We also need to investigate whether the increases in the commercial catch rates reflects improvements in fishing methods such that the increase does not reflect the underlying population.
- f. We also need to review the methodology of the Reef Visual Census and its use as a fishery independent index of population trends.
- g. Another catch rate issue is whether the change in contractors for MRFSS was responsible for the patterns in the recreational catch rates.
- h. Stock assessments in the Southeastern U. S. would benefit from a workshop addressing natural mortality and steepness and how the stock status conclusions depend on the chosen values.
- i. The performance of the assessment models could be evaluated for retrospective bias by running the models with simulated data.

#### **B. Review Workshop**

##### **1. Yellowtail Snapper Research Recommendations**

- a. Determine the release mortality rate for fish in the commercial, charterboat, headboat, and private/rental boat fisheries.
- b. Collect discard data (quantity, size, condition, etc.) from the headboat fishery. This could include modification to the current logbook used by headboats or employing observers; if observers are used, they could also collect biological data. Collection of discard data from the commercial fishery should continue. It is critical that a total (accurate) estimate of discards by sector (commercial, headboat, charter boat and private/rental boat) be available for the next assessment.
- c. Thoroughly evaluate the reef visual census CPUE index prior to use in future assessments.
- d. Examine alternative methods to incorporate recent increases in catching efficiency (“power-chumming”, smaller hooks, fluorocarbon leaders, GPS, etc.) into the commercial and recreational CPUE indices. This effort should lead to alternative methods to refine CPUE indices (electronic logbooks, observers, etc.), or alternative indices.
- e. Continue the use of annual age/length keys, and move to direct age estimation where possible. Cognizance should also be taken of the temporal and geographic effects on such collections.
- f. Seek better validation of age estimates.

- g. Continue research into stock structure, e.g. genetics.

## 2. General Research Recommendations

- a. Thoroughly examine estimates of natural mortality (M) and steepness (h) in a workshop setting. Such a workshop should not be limited to yellowtail snapper, but should make comparisons with other species.
- b. Examine the following issues with the MRFSS program:
  - (a) The contractor changed in the mid-1990s. Whether or not this affected CPUE trends should be examined.
  - (b) The level of intercepts increased after 1992, and from 1998/99 onwards, representatives of the State of Florida conducted the intercepts. What impact did this have on estimates and how should this CPUE index be incorporated into future assessments (as a continuous time-series or subdivided into one or more separate time series)?
  - (c) Private vessel owners leaving from their own private facilities are not currently sampled adequately. Is an adjustment factor used to account for this sector? Is this an important issue in Keys fisheries, given the large number of canals and private docks?
  - (d) Given the concerns about the MRFSS data, potential new methodologies to collect these data should be evaluated.
- c. Examine predator/prey interactions (and other ecosystem considerations).
- d. Develop methods to incorporate the effects of spatial variability into assessments.
- e. Put effort into developing better fishery-independent survey indices to assess fish stock status.

## 3. Comments Regarding Goliath Grouper

Goliath Grouper were initially considered during the data workshop but further assessment effort was not pursued due to a lack of data. The Review Workshop identified some potential assessment methods and overlooked datasets that ultimately led to an assessment of Goliath Grouper that was reviewed through SEDAR 6.

- a. *Estimation of population size.* Estimates of population size were considered to be crucial for future management. It was noted that, because of the apparently narrow home ranges and site fidelity, sampling throughout the geographic range would probably be important. Tag/recapture research and studies with data storage tags were mentioned as potential monitoring tools.
- b. *Demographics.* Monitoring the demographics of the population, particularly age composition, could provide valuable information. Noting that age determination of the species was difficult, the Panel suggested that effort be channeled into improving it.
- c. *Reproductive biology.* Developing further understanding of the reproductive biology of goliath grouper was considered important. Identifying spawning locations, duration and periodicity, and identifying whether there were spawning migrations, could be useful in identifying sites to conduct population surveys. Further, there would be value in obtaining more

information on early life history (eggs and larvae). It appeared that the survival rate of juveniles in mangroves and estuaries was good.

- d. *Historical abundance*. Obtaining information on historical abundance, perhaps via old logbooks, was considered a possibility as such information could enhance assessments.
- e. Other research material and topics considered as of less immediate importance or of questionable feasibility (in terms of collection of data) were:
  - estimating unrecorded mortality from accidental or intentional sources;
  - information on stock structure;
  - bioenergetics and trophic relationships (though note the comment above on the need for ecosystem management);
  - information identifying changes in mangrove abundance and distribution, and hence changing available nursery habitat (goliath grouper spend their first 6-7 years in mangrove areas, sometimes attaining as much as 50 lbs).

#### 4. Process and Procedure Recommendations

- a. Provide hard copies of materials for participants. Not everyone can access material via the Internet and download/print large quantities of material.
- b. The category “recreational catch” should include charterboat catches, private/rental boat catches, headboat catches and shore-mode catches (if appropriate).
- c. Review and evaluation of data during Data Workshops should be much more rigorous. All data should be plotted and the trends examined, and detailed recommendations should be documented and provided on the use of the various datasets. Assessment scientists should attend along with representatives of all major data collection programs (MRFSS, commercial logbook, TIP, etc.). Consensus needs to be reached on the use of specific datasets or estimates for incorporation in the assessments.
- d. The next assessments should use simple stock assessment techniques in addition to relatively complex stock assessment models, because simple techniques are easier to understand and describe, as well as being useful in confirming the results from the more complicated models. In particular, simple exploitation indices (total catch divided by abundance indices) should be examined to detect trends in fishing mortality. The simple trends in survey, CPUE, and catch data should be examined and described, and trends in survey and CPUE data compared. Trends in mean length or mean weight also provide information on exploitation and recruitment levels, and are worthy of presentation.

#### 5. CIE Consultant Recommendations

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- a. That consideration be given in future assessments to:
  - – the issues of year interactions, polynomial terms, and model selection in the standardization of CPUE ;

- – the use of less arbitrary data weightings;
  - – further validation of yellowtail snapper ageing, an examination of the “representativeness” of age-length keys, and more work on direct age estimation;
  - – better documentation of the rationale for the assumed values of natural mortality and recruitment steepness;
- b. That consideration be given, in writing of terms of reference for future SEDAR Assessment Review Panels, to
- either removing the phrase “including management recommendations” or giving clear guidance as to what sort of management recommendations are appropriate;
  - clarifying what is to be reviewed — the assessment or the assessment report — and, if the latter (not recommended), providing clear guidelines as to what is required in an assessment report.

## IV. SEDAR 3: ASMFC Atlantic Croaker and Menhaden

### A. Atlantic Menhaden Research Recommendations

- a. There is no adult abundance index to tune the population model.
  - Evaluate commercial purse seine fishery effort (vessel/weeks) series as a possible tuning
  - index in the model. Evaluate any measure of effort contained in this or other data series.
  - Evaluate the data collected in the Captain's Daily Fishing reports for an adult abundance
  - index. If these data are not useful, explore the utility of a commercial fishery-based adult
  - index, developed jointly with the fishermen, for future assessments.
- b. Recent relative productivities of menhaden nursery areas coast wide are unknown.
  - Investigate if there are any existing studies that could assist in evaluating current productivity.
  - Develop protocols to quantify contribution of different nursery areas to the adult stock.
- c. M-at-age is an improvement over constant M assumption. However, there is concern that not all key sources of mortality have been accounted for and little is known about the temporal patterns of mortality.
  - Identify key sources of non-fishing mortality for menhaden.
  - Enhance the coverage of the MSVPA to more predator and prey species.
  - Determine if there are temporal patterns in these sources.
  - Validate assumptions about applying results from MSVPA to the 1955-1980 period.
- d. There have been large changes in size-at-age over the 1955-2002 period. These trends are not a problem for the model but could have an impact on forecasts.
  - Evaluate historical change in size (weight and length) at age using existing data (e.g., scale incremental widths).
- e. There are patterns in residuals of numbers at age for commercial catch estimated by the model.
  - Investigate if the selectivity model is causing this pattern.
  - Look at spatial changes in fishing pattern as well as fish distribution.
- f. Current fecundity estimates are from studies in the 1980's and earlier.
  - Update the fecundity-at-size estimates and maturity ogives.
- g. Cannot address local depletion questions with the current model.
  - Investigate methods to determine the proportion of the stock that may reside in a particular area in any one season and whether regional reference points can be developed to address local depletion.
  - Extend these methods to track changes in distribution over time.

- h. Control plot determination of overfishing/overfished is based on point estimates only.
  - Develop uncertainty measures or risk analysis for control plots.
- i. It is difficult to distinguish between results of different models and model assumptions.
  - Develop measures (goodness of fit/complexity) to screen multiple models.
- j. The assessment model assumes a unit stock.
  - Test this assumption using otolith microchemistry and/or genetic markers.

## B. Atlantic Croaker Research Recommendations

The Review Panel rejected the initial Atlantic Croaker stock assessment due to critical data and model deficiencies. Specific steps necessary to correct the assessment were outlined as well as long term research and monitoring needs.

### 1. Recommendations to correct initial model

- a. Commercial landings did not include all removals from the population.
  - Evaluate North Carolina uncultured bait (“scrap”) fishery data and include in the commercial landings.
  - Evaluate the potential of applying the North Carolina uncultured bait fishery data to other states.
  - Consider at-sea observer data for discards and bycatch.
- b. The model used catch data from 1973 to the present but tuning indices were only used from 1981 to the present.
  - Extend the NMFS NEFSC bottom trawl survey data to 1973 for inclusion in the model.
  - Evaluate the difference between the Delta lognormal and stratified mean estimates from NMFS NEFSC bottom trawl survey.
  - Evaluate the VIMS survey data for possible inclusion in the model.
- c. The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis.
  - Re-evaluate after inclusion of the full time series of NMFS NEFSC and VIMS trawl survey data.
- d. The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and model recruitment estimates and, therefore, provided higher weights to these surveys.
  - Evaluate the consequences of alternative weighting schemes.
  - Provide detailed justification for the final choice of weighting scheme.
- e. Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
  - Investigate the distribution and movement of croaker by age and season.
  - Compare life history parameters over the full distribution of croaker.
- f. The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population.

- Compare non-age assessment models, such as the Collier-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.
- g. Determination of overfishing/overfished were based on point estimates only.
  - Estimate the error distribution for current estimates of  $F$ , and reference points.
  - Determine whether, given error distributions determined above, target  $F$  and threshold  $F$  could be distinguished from estimates derived from the assessment model.
  - • Consider revising  $F$  target reference point relative to the previous bullet.

## 2. Research Recommendations

- a. Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
  - Conduct tagging and otolith microchemistry studies to address the justification for regional assessments.
- b. Difficult to understand what component of the population the surveys were tracking.
  - Include maps of fishery and survey areas in future reports.
- c. A single growth curve based on data from North Carolina was applied over all years and for whole area.
  - Evaluate the applicability of the North Carolina growth curve to all areas (spatial variability).
  - Investigate inter-annual variability in growth.
- d. A single natural mortality estimate was used for all ages and years.
  - Develop age-specific  $M$  for inclusion in the model.
- e. Trends in the recruitment deviations may indicate temporal bias in the recruitment model.
  - Assess whether changes in potential population reproductive capacities have changed by quantifying patterns in the maturity ogive and size- and age-dependent fecundity.
  - Assess whether density dependent shifts in age- or condition-dependent timing of age at maturity have occurred as in other sciaenids.
  - Assess whether temporal patterns in recruitment slope or asymptote have occurred.
- f. There are no standard protocols for ageing of Atlantic croaker.
  - Conduct a workshop to develop and approve ageing standards for Atlantic croaker.
  - Continue collection of coast-wide age samples from fisheries-independent surveys and length samples from the MRFSS.
- g. Selectivity curves were used for both commercial and fisheries-independent indices.
  - Evaluate culling of the larger fish out of the survey indices to better match the assumed selectivity.



## **V. SEDAR 4: South Atlantic Snowy Grouper and Tilefish**

The SEDAR 4 Data Workshop considered numerous Caribbean and South Atlantic deepwater snapper-grouper species. Data were tabulated for all assigned species, and assessments prepared for the two judged to have adequate data for quantitative assessment – South Atlantic snowy grouper and tilefish (“golden tilefish”).

### **A. Tilefish**

#### **1. Assessment Workshop Research Recommendations**

- a. Ageing discrepancies between laboratories should be resolved. State and Federal investigators should continue efforts to standardize techniques and resolve the systematic discrepancies in age determinations. Additional research should be undertaken to verify and validate age determinations.
- b. Sampling programs are required to quantify discard rates. Research should also be initiated to identify management strategies that could reduce discard mortality. Discarding may become an increasingly important concern as the stock recovers and compliance with measures such as trip limits become more difficult.
- c. Fishery-independent data collected by the MARMAP program are important to understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment. However, it has been noted that the MARMAP sampling programs do not have ideal extent, both in area coverage and in sampling intensity, for many important species in the South Atlantic snapper-grouper complex. It would be highly desirable for the MARMAP program to receive sufficient funding to expand its coverage and thus provide improved measures of stock abundance.
- d. Recent West Coast stock assessments were criticized by the U.S. General Accounting Office (GAO 2004) for not including at least one NMFS (i.e., fishery-independent) data source of sufficient scope and accuracy collected from an unbiased, statistical, and scientifically designed program. Effort should be devoted toward developing an independent data source for the South Atlantic snapper-grouper complex that meets the requirements outlined in the Stock Assessment Improvement Plan and the 1998 National Research Council report on improving stock assessment. This could be done through the MARMAP program or otherwise.
- e. Representative age, length, and sex composition data are needed for all fisheries, seasons, and areas. Sampling should be distributed according to the pattern of landings. Initial sampling targets are suggested as 20 age structure samples per age and 5 length samples per age sample. This provides approximate tilefish sampling targets of 1000 age structures and 5,000 lengths.
- f. Additional life history and biological research is needed, especially that which covers the full geographic range of the species. Among other items, fecundity

and reproductive research is needed (batch fecundity and frequency at age and/or size).

## B. Snowy Grouper

### 1. Assessment Workshop Research Recommendations

- a. Ageing discrepancies between laboratories should be resolved. State and Federal investigators should continue efforts to standardize techniques and resolve the systematic discrepancies in age determinations. Additional research should be undertaken to verify and validate age determinations.
- b. Sampling programs are required to quantify discard rates. Research should also be initiated to identify management strategies that could reduce discard mortality. Discarding may become an increasingly important concern as the stock recovers and compliance with measures such as trip limits become more difficult.
- c. Fishery-independent data collected by the MARMAP program are important to understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment. However, it has been noted that the MARMAP sampling programs do not have ideal extent, both in area coverage and in sampling intensity, for many important species in the South Atlantic snapper–grouper complex. It would be highly desirable for the MARMAP program to receive sufficient funding to expand its coverage and thus provide improved measures of stock abundance.
- d. Recent West Coast stock assessments were criticized by the U.S. General Accounting Office (GAO 2004) for not including at least one NMFS (i.e., fishery-independent) data source of sufficient scope and accuracy collected from an unbiased, statistical, and scientifically designed program. Effort should be devoted toward developing an independent data source for the South Atlantic snapper-grouper complex that meets the requirements outlined in the Stock Assessment Improvement Plan and the 1998 National Research Council report on improving stock assessment. This could be done through the MARMAP program or otherwise.
- e. Representative age, length, and sex composition data are needed for all fisheries, seasons, and areas. Sampling should be distributed according to the pattern of landings. Initial sampling targets are suggested as 20 age structure samples per age and 5 length samples per age sample. This provides approximate snowy grouper sampling targets of 700 age structures and 3500 lengths.
- f. Additional life history and biological research is needed, especially that which covers the full geographic range of the species. Among other items, fecundity and reproductive research is needed (batch fecundity and frequency at age and/or size).
- g. Further research is needed into the implications of sex change for fishery management.

## C. Recommendations from the Review Workshop Consensus Report

### 1. Process and Procedure Recommendations

- a. Several members of the Panel found the complete documentation of equations and the inclusion of model code particularly informative, and recommend that such information become a standard component of SEDAR assessment reports. Further, it is recommended that model input data files also be included in future reports.
- b. The Review Panel suggests that two additional pieces of information be provided in future reports: 1) a table of model parameter estimates, and 2) a thorough documentation of the process that led to the initial model configuration.
- c. The Review Workshop also recommends that future data workshop reports provide greater evaluation of input data. In many instances data are provided with little consideration of the 'evaluation of quality and reliability' as required in the Terms of Reference.
- d. The Review Panel suggests for future SEDAR's that confusion may be reduced by providing a brief description of the process that leads to assessing only a subset of those species addressed in the Data Workshop.

### 2. Research Recommendations

- a. Regarding ageing methods, the Review Panel recommends that ageing validation should be accomplished prior to addressing concerns over differences in age determinations between the various labs.
- b. Regarding age sampling, the Panel recommends that the suggested initial sampling rate for age structures be clarified to avoid the suggestion of age as a sampling strata. The intent is to establish an initial age sample of 20 times the number of ages in the population. The Review Workshop also recommends that stratification by length and development of appropriate age-length keys be considered as a possibly more effective and economical approach to inferring age composition than attempting random age sampling. Regardless of the method ultimately chosen, it is most important to provide adequate age and length sampling through a rigorous and statistically valid sampling program.
- c. The Panel recommends exploring the relative importance of age sampling in models of the type used here to assess snowy grouper and tilefish. Such analysis could help identify the best allocation of limited monitoring resources.
- d. The Panel supports the snowy grouper recommendation regarding research into the implication of sex change. The Review Workshop adds that future assessment models addressing species which undergo sex change should provide model results that incorporate sex-specific information.

## D. Comments of CIE contractors

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- a. The Panel's, and that of subsequent readers', ability to review the Workshop Reports was compromised in that details of analysis and discussion were lost through the multi-step process.

- b. The acceptance criteria for LFs and AFs could be improved. Acceptance criteria should be based on whether each LF or AF is representative of the catch.
- c. The way landings were modeled in these assessments could be improved.
- d. It would be better to estimate selectivities as functions of length, rather than of age.
- e. Statistical models, like those used here, provide a powerful tool for dealing with uncertainty. They allow us to assign appropriate weights to different sources of information and they tell us how certain we can be about our inferences. In practice it is impossible to gain the full power of these models because we are unable to correctly specify all the statistical components of the model and so are often forced to add arbitrary non-statistical components. I suggest that our aim should be to minimize these non-statistical components.
- f. There is clearly a need for validation of the ageing of both species so that we can have more confidence in the AFs and the age-length conversion matrix.
- g. The MCB analyses are a good way to replace one type of sensitivity analysis whose aim is to quantify uncertainty. Another type of sensitivity analysis which could have been useful in the Workshop would have been to rerun the initial run several times, each time dropping one type of data, thus showing the extent to which the assessments depended on each data type.
- h. There were several small problems in both assessments, mostly in the documentation.
  - It should be made clear that the calculation of generation time involves only female fish
  - In fitting the von Bertalanffy equation the assumption used was clearly that the *standard deviation* of length at age was proportional to the mean length (not the *variance*, as stated).
  - In the formula for the age-length conversion matrix the superscript 2 is misplaced.
  - Equations should be given for the per-recruit calculations.
  - It might be worth checking the method of fitting the maturity ogives for both species because the fitted curve is to the right of all data points for which the proportion mature is not near 0 or 1
  - In the tables documenting the model it might avoid confusion if a clear distinction were made between fixed parameters (e.g., growth parameters, LF sample sizes), estimated parameters (e.g., selectivity parameters, fishing mortalities), derived quantities (e.g., length at age, selectivity at age) and observations (which are characterized by having an associated likelihood component, e.g., CPUE, LFs).
- i. Snowy Grouper : It might be useful to try some more sophisticated techniques (e.g., GAMs or tree-based regression) to seek an explanation of the unrealistic MCB runs. This may be informative. It might be worth dropping the Chevron trap CPUE index (for reasons given above). It seems a matter of some concern that more than half the catch is of immature fish. It is worth considering explicitly modeling the three categories of fish: immature, mature female, mature male (i.e., keeping track of numbers of fish by age and category)

- j. **Tilefish:** It would be worthwhile to explicitly model sex (i.e., to keep track of numbers by sex, as well as by age — the assessment report stated that this was not possible because the landings and LFs were not sex-specific, but I don't see why). As females are smaller at age than males they probably do not have the same selectivity at age as males do, so modeling selectivity as length-based would be better.



## **VI. SEDAR 4: Caribbean Deepwater Snapper Grouper**

Data were compiled for several Caribbean Deepwater snapper grouper species during the SEDAR 4 data workshop. Significant data deficiencies were noted, leading to an extensive list of recommendations.

### **A. Recommendations for the collection of landings statistics**

#### **1. Puerto Rico**

- a. In Puerto Rico it is important to determine the feasibility of expansion factors to estimate total catch. The information used to calculate expansion factors by year needs to be verified. Reporting of single trips, rather than multiple-trips per record in the catch report forms should be encouraged. This would greatly facilitate the estimation of effort and CPUE.

#### **2. U.S. Virgin Islands**

- a. The collection of landings statistics in the U.S.V.I. should also aim at breaking down the reported catch into species, since analysis of the current species-groupings is not straightforward without additional information on species composition from TIP or alternative sampling programs.
- b. The information used to calculate expansion factors by year (number of fishermen registered, reporting, etc.) needs to be corroborated, and the feasibility of these expansion factors for estimation of total catch needs to be determined.
- c. Further examination and analysis of the data sets available to date would require an improved collaboration between local and SEFSC biologists. In particular, it is important to determine what species were commonly grouped within each gear-type classification in the 'Old Report Forms'. This information would help to break up the aggregated catch from years prior to the implementation of the Trip Interview Program.
- d. Landings files for most years for the period 1974-2002 have now been compiled and provided to the SEFSC. However, some coding, typing and other errors, duplicates, as well as gaps in the time series still persist. Action is required to verify, correct the errors and edit those data for future use.
- e. Significant effort should be geared toward the standardization of the landings series.
- f. Finally, it would be important to encourage fishermen to submit all the monthly catch reports, to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.

### **B. Recommendations for the Trip Interview Program (TIP)**

#### **1. General Recommendations**

- a. Encourage the development of length-weight equations from the existing information in TIP

2. Specific recommendations for Puerto Rico TIP include

- a. Record the total weight landed by species for each trip.
- b. Record the sampled fractions.
- c. Coding errors in length and weight units must be corrected.

3. Specific recommendations for U.S. Virgin Islands TIP

- a. Encourage/ aid the development of a commercial logbook system to enable estimation of reporting fractions.
- b. Increasing the fraction of interviewed trips (the sampling fraction needed to achieve specific objectives will depend on the objective and the variability of the observed species composition) to properly determine the species composition., which is needed to break out the aggregated catches.
- c. Conduct regular interviews in St. Thomas and St. John, with the goal of increasing the sampling fraction.
- d. Encourage port samplers to complete all the fields in the sampling form. Often the trip effort information is missing, which is essential for the estimation of catch rates or relative indices of abundance.
- e. Continued and enhanced collaboration between the NMFS SEFSC scientists and the local USVI biologists and data collection agents.
- f. Correct coding errors, particularly in length and weight units.
- g. Some questions that could be posed to local USVI biologists to improve the analyses of TIP data are:
  - 1) How is the species in question landed, gutted or whole, etc.? How are length and weight typically recorded?
  - 2) Is the species in question targeted or by-catch of another target species?
  - 3) What species are often landed in association with a given species?
  - 4) Is the species ever reported under a different name? For example, another species id, or a genus or family designation?
  - 5) Are there environmental factors that might influence the abundance or catch rates of a given species?
  - 6) Have management efforts, economic impacts, weather events, or other factors influenced fishing effort, catch rates or targeting?
  - 7) Have fishery attributes changed (gear, boat type, technology, species targeted, skill of fishers etc.) changed during the period of monitoring. If so how?
  - 8) Are interviewed trips chosen randomly? If not, what potential biases might exist in the dataset?

C. Recommendations for the estimation of catch rates

- a. In Puerto Rico the total catch by species for each trip in the TIP data is required. It has to be determined whether assumptions can be made regarding sampling fractions in TIP data to allow construction of Puerto Rico's CPUEs.
- b. The SEDAR Committee recommended that CPUEs for the U.S.V.I. be recalculated for a truncated time series (1984-1991), given that sample sizes for subsequent years are very limited.

- c. It is important to explore the availability of other fisheries-independent CPUE series.
- d. Standardization approaches for data-poor species, different from the delta-lognormal, need to be evaluated.
- e. The use of bootstrapping to estimate confidence intervals of the CPUE series should be investigated.
- f. The use of multivariate statistical analysis is recommended to identify the appropriate pool of gears to use when measuring effort.

#### D. Recommendations for the analysis of species composition

- a. In Puerto Rico, it is important to recommend increased interviews with an emphasis on representative sampling, and to record the sampling fraction.
- b. Eventually, if Puerto Rico moves toward reporting landings by species, it will be advisable to compare TIP and landings species composition.
- c. In the U.S.V.I., it is important to examine the species composition on handline and trolling trips separately, and to evaluate whether sampling is representative.

#### E. Recommendations for the Caribbean SEAMAP Survey

- a. Encourage continued annual surveys throughout the area.
- b. Determine the spatial/temporal coverage in fine detail.
- c. Data analysis and interpretation must address the temporal patterns observed in the size frequency distributions.
- d. Regarding the shallow reef fish monitoring fishery-independent survey in Puerto Rico:
  - Coordinate with NMFS to make this data readily available.
  - Explore the CPUE and size-frequency data available from this data set.
  - Compare with the other SEAMAP data set.

#### F. General Recommendations

- a. Continue and improve collaboration with scientists from Puerto Rico and the U.S. Virgin Islands. Advice is needed in terms of handling the data, interpreting it, correcting coding errors, duplicates, and other problems in the data collection, recording, and editing systems. Local scientists and staff can help to understand the sampling protocols, documenting the observed trends, and filling out persisting gaps in the time-series.
- b. Continued data exploration must be made with consultation of the local laboratories/agencies, including the biologists, field agents, and data-entry staff.
- c. There is a possibility that the data will have limited value for assessment in the near future; however, continued analysis and improved data collection may greatly increase the utility of the information. The fishery-dependent data from Puerto Rico in particular has a good potential for use in stock assessment.
- d. Emphasis should be placed on the improvement of the TIP sampling program, as catch rate standardization, catch composition and size-frequency analyses will continue to rely upon this information. However, fishery-independent

surveys and the collection of other biological data are extremely important to develop alternative indices of abundance.

- e. It is recommended that early biological or biostatistical sample data for the U.S. V.I., from the early to mid 1970's be computerized and made available for future data workshops. It is strongly recommended that formal discussions between NMFS, SEFSC TIP program coordinator and the USVI DFW are held to ascertain what steps/procedures, etc. are needed to improve sampling in the U.S.V.I. fisheries. Similarly, discussions should be initiated between Puerto Rican biologists and NMFS assessment staff to identify any remaining historical data sets not yet available. It is noted that an effort to computerize Puerto Rico biostatistical samples from the mid 1980's is ongoing (N. Cummings personal communication).
- f. It is recommended that analytical efforts expended by the recent working group members be continued. First, some attention should be given towards identifying or selecting which species should be assessed more quantitatively. The Caribbean reef fish fisheries are complicated comprising a mix of many species that are harvested by a number of gears.
- g. It is recommended that additional workshops such as this one be implemented to further develop the information for assessment, especially for those species and fisheries for which extensive information exist.
- h. It is noted that that strong cooperation of all agencies and local scientists involved would be beneficial.

#### G. Data Workshop Conclusions on the Availability of Data for Stock Assessments

The workshop participants reviewed summaries of the information presented by the Caribbean group which might be used to assess the status of silk, queen and blackfin snapper and sand tilefish on each platform (Table 64). For the Puerto Rican platform the availability of information was examined for three data sources: Puerto Rico, the United States Virgin Islands and the British Virgin Islands.

##### 1. Puerto Rican platform

- a. For Puerto Rico, reported commercial landings are available in electronic form only since 1983 although the local fisheries were exploited since the early 1900's. Efforts are underway to obtain previously computerized data files of landings for 1963-1982 (N. Cummings personal communication). These early landings statistics could better characterize fishing mortality levels on this multi-gear/multi-species fisheries complex and efforts should be made to extract these data. Snapper landings in the Puerto Rico database are apparently aggregated for multiple species within the 'silk snapper group' in the Puerto Rico database before 1997 (after 1996 silk snapper is apparently not aggregated with other species) (Aida Rosario personal communication). Estimates of the landings of those snappers probably can be made given some assumptions about the species composition information from dockside sampling after considerable additional effort and consultation with Puerto Rican biologists who are familiar with the data collections and fisheries. It is strongly recommended that cooperative analyses be initiated between scientists from Puerto Rico and NMFS to accurately quantify species

composition from these data. Analyses should take into account the highly variable operations of the local fisheries.

- b. For sand tilefish annual landings are less than 1,000 lb and in most years less than 50 lb. The dockside sampling (TIP) data which might be used for species composition had very few sand tilefish recorded so that if sand tilefish landings had been included in the various unclassified categories, it would not be possible to estimate the amount of sand tilefish in such landings.
- c. For Puerto Rico the recreational harvest of the three snapper species are thought to be relatively low compared to the commercial landings. Because they are thought to be low, the absence of recreational harvest estimates prior to 2000, was thought not to be a major problem for assessment of these stocks, given the other uncertainties in the data sets.
- d. The landings in the United States Virgin Islands have not been recorded by species; therefore species composition information would be needed for St. John and St. Thomas to estimate catches by species. Only limited species composition samples have been collected from those islands, therefore estimates of the landings by species have not been made. Additionally there is no information on possible recreational harvests of these species around those islands. Also there was no information available at the workshop on the British Virgin Island fisheries. It is noted that an effort is ongoing to obtain historical information on landings and biostatistics samples for the British Virgin Island (BVI) fisheries for use in future data workshops regarding the Puerto Rico platform. It is also recommended that biologists from the BVI fisheries department be included in future data-workshops that involve the appropriateness of the use of data from the BVI in characterizing reef fish stocks on the Puerto Rican platform.
- e. Information on size composition is available for the three snappers from the Puerto Rican commercial fishery and a limited amount of information is available for silk snapper from the recreational fishery. Additionally, there are ample observations on the size of sand tilefish taken in the fishery-independent sampling near Puerto Rico, and there possibly are sufficient samples for silk and blackfin snappers from those surveys. For St. Thomas and St. John there are few or no size samples from the commercial and recreational fisheries. The workshop participants have not determined whether there were fishery independent samples from that area.
- f. It is expected that crude information on commercial catch rates could be obtained for the three snappers from expanded annual landings and estimated deep water effort for Puerto Rico; it seems unlikely however that the TIP data could provide reliable indices of abundance for those species, because it does not appear that the total landed weight for a species was recorded and it appears that in general not all fish were measured. It is likely that the fishery independent sampling could be used to develop an index of abundance for sand tilefish, and probably also for silk and blackfin snapper. There do not seem to be sufficient data for calculating fishery dependent catch rates from St. John and St. Thomas.
- g. In summary for the Puerto Rican platform:

- For the Puerto Rican platform it seems that multiple years of commercial landings might be developed for the three snapper species from reported catches and species composition data. However it would best if these tasks were done in consultation with scientists familiar with the fisheries and the specific datasets. Those catches would however represent only a part of the total removals.
- Some information can probably be obtained from the TIP collected size frequency of the commercial catch for the three snappers. It is recommended that analytical effort focus on further review of the available size frequency samples. Of all of the available data sets, the fishery independent sampling on the Puerto Rican platform conducted by the NMFS, SEFSC and by the PR, DNER, FRL FSP may be most likely to provide indications of the abundance trends of at least silk and blackfin snapper and sand tilefish on the Puerto Rican platform. It is recommended that analytical efforts focus on aggregating those data sets and developing abundance indices.

## 2. St. Croix platform

- a. The landings data from St. Croix probably can be disaggregated into species-specific data sets, but is restricted to a limited number of years when species composition is available and the landings are categorized by species-groups. However, the generally low sampling fractions indicate that there would be very great uncertainty about the estimated landings by species. Disaggregating the catch from the earlier years, when no species composition is available and landings were recorded by gear category may be cumbersome. Added to these issues is the possible imprecision in the estimation of the total catch based on expansion factors. These will be more reliable once compliance reports are reviewed and reanalyzed for the full time-series. Given these uncertainties, the overall utility of the catch for use in stock assessment is questionable at the moment, particularly for years prior to the implementation of the TIP program.
- b. The decrease in the mean size and the size of the larger (80<sup>th</sup> percentile) of both silk and queen snapper landed in St Croix between 1983-1996 could have been an indication of over harvesting. Additionally that the majority of silk snapper are below the estimated size at maturity would have been of substantial concern if fishing mortality rates were high. The standardized commercial catch rates calculated from the TIP samples from St. Croix were based on relatively few observations and the time series ends in 1991 (too few observations in subsequent years). Thus, they do not provide information on the current status of the resource. It is recommended that cooperative efforts be initiated by NMFS, SEFSC and the USVI DFW to address improvements in sampling the near-shore reef fish fisheries off these islands. It is possible that the fishery independent sampling (1992-1994, 1999, 2002) conducted by the NMFS, SEFSC Pascagoula Laboratory off the Virgin Islands could provide useful information, but it was not clear to the workshop participants what portion of that sampling occurred on the St. Croix platform. Once again

it is recommended that examination of the fishery independent data be given high priority in terms of expending analytical time.

- c. Participants at the workshop understood that additional fishery independent data sets may exist for both the Puerto Rican and the St. Croix platforms particularly from *in situ* observations. It was recommended that efforts be made to obtain that information for possible use in developing additional indications of population status.



## VII. SEDAR 5: Atlantic and Gulf of Mexico King Mackerel

### A. Assessment Workshop Recommendations

#### 1. Assessment Data Needs

- a. Available growth data needs to be evaluated for improved application to historical catch at age.
- b. Available sex ratio at size data needs to be evaluated to determine how sex ratios vary by size.
- c. Methods that allow for including error estimates in the catch at age matrix need to be developed.
- d. Continued evaluation of tag data, ongoing otolith microchemistry and shape analysis studies, and micro-satellite genetic marker data to improve estimation of stock structure and mixing proportions.
- e. Field studies are needed to develop or improve batch fecundity, spawning frequency, and age specific fecundity estimates, including size and age at maturity.
- f. Western Gulf king mackerel catches need to be aged for use in age length key analyses.

#### 2. Assessment Modeling Needs

- a. Currently, it is only possible to model two stocks using tagging data to model mixing rates (Porch 2003). In the long term the Data Workshop and Assessment Panels recommend that assessment models be developed which can model multiple stocks and/or areas and which can use multiple types of data that enable mixing rate estimations (including tagging data and biological tags including elemental and isotopic composition, genetic information and morphological information).
- b. Sensitivity of CAA and management benchmarks to changes in the growth model used in the stochastic ageing procedure need to be evaluated.
- c. A three-area age structured model with forward projection formulation may result in better estimation of the impact on stock status of mixing zone dynamics using existing tagging data and most recent recruitment estimates.
- d. Sensitivity runs considered in this assessment indicate two areas where additional research is critically needed to improve stock status evaluation. The Assessment Workshop Panel advises that stock assessment uncertainty will not be reduced until these issues are resolved. These two areas are:
  - Methods used to allocate catches to age class when samples are inadequate for constructing age-length keys. Sensitivity runs based on alternative growth models suggest that estimates of stock status are sensitive to differences in growth models when they are used to estimate age from size in the absence of an ALK. The raw data used to develop the historical growth models (Manooch *et al.* 1987; Collins *et al.* 1988) are no longer available, and thus it may not be possible to provide the type of identical analyses of current and historic data that are necessary to evaluate whether growth model differences are simply due to analytical technique or

whether the differences truly reflect changes in growth over time. The Panel recommends that current growth data (1987 onward) be modeled with increased resolution to refine growth model parameters. Specifically, decimal rather than integer ages should be modeled, and attention should be paid to collection date, birth date, and annulus formation date.

- Sensitivity analyses of stock mixing impacts on stock status determination. Results suggest that the assumed degree of stock mixing has relatively equivalent impacts on the perceived productivity of each migratory units, but divergent impacts on stock status determination. The estimated status of the Gulf of Mexico Migratory Unit is strongly influenced by mixing assumptions, while status determination of the Atlantic Migratory Unit varies minimally. Both the Data and Assessment Workshop Panels devoted significant discussion and effort toward resolving stock allocation within the mixing zone. Based on Data Workshop recommendations, the SEFSC reconsidered mixing rates through updated analyses of tag data, developed an alternative assessment framework to incorporate tag-based stock mixing estimates into a VPA framework, and developed stock estimates with the base assessment configuration for a variety of mixing rates within the mixing zone. However, none of these efforts have led to a consensus recommendation on the actual level of stock mixing.
- e. The Assessment Workshop Panel believes that analyses of otolith shape and microchemistry, as presented in the progress reports discussed at the Data Workshop, offer a promising approach to resolving stock mixing. The Assessment Workshop Panel strongly recommends that this work be continued for several additional years to increase sample size, continually improve the resolution of the method, and better account for potential annual variation in mixing. The Panel also recommends increased sampling intensity within the mixing zone, with sample allocation that is representative of the fine-scale geographic distribution of the catch within the mixing zone. Also an effective tagging program designed specifically to address the mixing issue could increase the quality and quantity of available data.

## B. Review Workshop Recommendations

### 1. Research Recommendations

- a. The RW Panel noted that major concerns remain about the growth curves used to age the catch in some years and areas, the fecundity-length relationship used to estimate spawning stock, and the degree of mixing of the Gulf and Atlantic migratory groups in the winter fishery mixing zone. The RW Panel also expressed concern about the limited number of fishery independent indices of abundance available for VPA calibration.
- b. The RW Panel recommends enhancing ongoing research programs and implementing new research programs to collect fishery independent data (e.g., length measurements, age structures, fecundity measurements) to improve the accuracy and precision of current estimates of growth, fecundity, and stock mixing. Spatial variability in size at maturity and fecundity at age should be evaluated among regions/migratory groups.

- c. The data collection program should also be designed to provide fisheries independent indices of abundance for the full age range in the stock. This consideration should have a strong influence on the design aspects [gear, season] of the recommended research programs. These programs might include research sampling targeting spawning aggregations, research sampling targeting juveniles, tagging studies specifically designed to provide information on mixing rates, and hydro-acoustic sampling. Scientists should seek the advice of members of the commercial and recreational fishing communities in the design of these programs.
- d. The RW Panel suggested that the MRFSS indices of abundance could be recompiled to address two issues: 1) consider incorporation of the January-June intercept data in addition to the current July-December data, and 2) consider restriction of the sample data to the age classes most likely to contribute to the respective catch types (i.e., recompile the indices including only Catch Types A, and restrict the corresponding length composition to legally landed fish).
- e. The RW Panel also recommended the future application of different assessment models to provide alternative perspectives on the status of king mackerel stocks (e.g., those including estimation of the likely degree of error in the fishery catch-at-age, and/or those which employ forward-projecting computation approaches).
- f. One growth model should be developed for the splitting of catch at length data into catch at age data and another one that can be used for stock related data like weight at age in the stock, maturity at age in the stock and the like.
- g. Available sex ratio at size data needs to be evaluated to determine how sex ratios vary by size.
- h. Western Gulf king mackerel catches need to be aged for use in age length key analysis.
- i. The commercial fishery tuning indices should be further developed and it seems important that this is done in cooperation with fishers with an intimate knowledge of the way the fishery is prosecuted.
- j. Age composition of commercial and recreational discards is needed.
- k. Discard mortality rates are needed.
- l. Tuning indices should be weighted according to their internal variability, the part of the stock covered by the index, correlation with other indices etc. For instance it is realized that using their individual degree of correlation to the VPA stock abundance estimates could be problematic due to the circular logic feature of this approach.
- m. Data from Mexican catches need to be obtained, probably via initiatives for closer cooperation with Mexico. In this connection there is a need to look into whether the eastern and western Gulf King Mackerel are separate stock components.
- n. Tagging programs specifically designed to examine the mixing should be developed. Otolith shape and microchemistry and maybe micro-satellite DNA analysis are promising methods that should be pursued.

- o. Mixing of the stocks in the mixing zone should be investigated also the during summer period.

## 2. Process and Procedure Recommendations

- a. The amount of documentation and issues to be dealt with are significant. Some of the documentation could have been sent out earlier to the RW Panel, for instance background material and the data workshop material. That would have eased the task of getting deeply into the substance of the material, especially for the external reviewers, who (almost by definition) were not beforehand familiar with the assessment.

### C. Comments from the CIE Contractors

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- a. The amount of reports and other material to read before the meeting was extensive. There was only little time to do this, about two weeks. It would be useful if some of the material were sent out as early as possible. It should be possible to send out previous assessment reports, background articles, and the Data Workshop report, several weeks earlier.
- b. A complete description of the assessment with all the input data files and the precise settings of the model would be nice to have in one document. It was a bit difficult to find precisely in which document to look for the various details. The level of details and data files should allow for an exact and easy repeat of the calculations.
- c. Fishers (and nongovernmental organizations (NGOs)) contributed during the meeting some information on CPUE series, the fishery and the management regulations effects on this, and the like. It is, however, important that political issues do not enter the discussions. It might, however, be important for the entire process that fishers participate, or at least get the opportunity to observe what is done, in order to secure transparency and trust in the system. However, extra time would need to be spent on explaining things to non-scientists and in balancing the statements put forward so that fishers and NGOs correctly understand the issues.
- d. My task as Chair for the meeting was a bit difficult because most panel members were more familiar with the process than I was. Maybe a bit more information about the duties of the Chair would be useful. Alternatively, another member of the Panel could be the Chair, and one of the CIE Experts could be appointed as the lead expert and perhaps still be responsible for the reporting.
- e. Maybe the reviewers (and other Panel members) could, to the extent possible, state before the start of the meeting what sensitivity runs they want to see in addition to what has been presented in the documents sent to the Panel. This will allow SEFSC staff more time to prepare the runs, and it will make mistakes less likely.
- f. The timing of the whole process from the last data sampled in 2001/02 and until now (start of 2004) with the aim of giving advice for 2005/2006 could be

improved. It is a very long time span, and there is a large risk for the things in the fishery and the stock to have changed in between meeting processes. It should be possible to shorten this time span so that the advice for 2005/2006 can be based on data from 2003/2004.

- g. It is important that estimates of age-composition of commercial and recreational discards, and of discard mortality be obtained. It is strongly recommended that fisheries-independent surveys be expanded, and eventually assigned more weight in the tuning process.
- h. Fisheries-independent surveys should be designed to provide indices of abundance for the full age range in the stock. This would likely require multi-seasonal sampling and the combined use of multiple sampling gears and hydro-acoustics.
- i. Data from Mexican catches need to be obtained to improve the accuracy of Gulf king mackerel assessments.
- j. If feasible, I recommend that the uncertainty in assessments caused by sampling variability in estimated landings in number by age be further evaluated.
- k. The use of multiple survey indices for “tuning” can introduce a bias of unknown magnitude in the assessments of Atlantic and Gulf king mackerel. One way to reduce such bias is to combine overlapping survey estimates by using a composite estimator with weights determined by coverage and precision of each abundance series, and then apply the combined series in tuning the model. Additional post-stratification might be appropriate when surveys overlap only in a sub-area or during a limited time.



## VIII. SEDAR 6: Goliath Grouper and Hogfish

A SEDAR Review Workshop convened to review assessments of Goliath grouper and hogfish snapper. The Goliath grouper assessment was prepared in response to recommendations from the SEDAR 3 (Atlantic Yellowtail snapper) review workshop. The hogfish snapper assessment was prepared by contract with the State of Florida and reviewed by request.

### A. Goliath Grouper

#### 1. Data Workshop (SEDAR 4) Research Recommendations

The top four research topics were:

- a. **1. Estimation of population size** - Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparent restricted home ranges and high site fidelity, sampling throughout the geographic range would probably be important. Tag/recapture studies were mentioned as a potential monitoring tool. (NB – to better define their geographic distribution, the State of Alabama ([http://www.dcnr.state.al.us/mr/goliath\\_grouper.htm](http://www.dcnr.state.al.us/mr/goliath_grouper.htm)) and the State of Mississippi (<http://www.dmr.state.ms.us/Misc/Species-of-concern/>) recently put up hotline 8
- b. notices on their websites. Louisiana plans to add a link to their site, and Texas should follow suit).
- c. **2. Demographics** - Monitoring the demographics of the population, particularly age composition, could provide valuable information (as it has for red drum in the Gulf of Mexico).
- d. **3. Reproductive Biology** - Developing further understanding of the reproductive biology of goliath grouper was considered quite important. Identifying spawning locations, duration and periodicity could be very useful for identifying sites to conduct population surveys.
- e. **4. Historical Abundance** - Obtaining information on historical abundance, perhaps via old logbooks, was also considered important.

Four other research topics were also considered, but it was thought that they were either less important, or less likely to be completed:

- f. **1.** It could be very useful to have estimates of unrecorded mortality from accidental or intentional sources, but obtaining such information would be very difficult.
- g. **2.** Additional information on stock structure was considered important.
- h. **3.** Some thought that it would be useful to have a greater understanding of goliath grouper bioenergetics and trophic relationships. Others asked how that information would assist in a stock assessment.
- i. **4.** Information identifying the changes in mangrove abundance and distribution, thereby changing available nursery habitat, could assist in developing predictions of future abundance.

## 2. Review Workshop Research Recommendations

- a. Estimation of population size: Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparently restricted home range and high site fidelity characteristic of adults, sampling throughout the geographic range would be important. Tag/recapture studies were mentioned as a potential monitoring tool.
- b. Estimates of on-going mortality: The issue of ongoing mortality was of critical concern to the Review Panel. Anecdotal information with regard to various sources of this mortality was presented. These sources included longline by-catch, post-release mortality, and illegal harvest. It is extremely important that these sources of ongoing mortality be identified and the magnitude of this mortality estimated.
- c. Investigations of stock structure: This question was repeatedly raised. The assessment reviewed by the Panel was of necessity limited to south Florida owing to the geographic coverage of the data and the absence of data concerning the stock structure.
- d. Demographics: Monitoring the demographics of the population, particularly age composition, could provide valuable information.
- e. Reproductive biology: Developing further understanding of the reproductive biology of Goliath Grouper was considered important.
- f. Historical abundance and exploitation: Obtaining information on historical abundance was also considered important.
- g. Survey data. While the Review Panel considered it in the highest degree important to continue the current surveys, it recommended that data collection could be improved by extending survey efforts to better cover the full historical range of the stock.

## 3. Review Workshop Process and Procedure Recommendations

- a. The review would have been facilitated if the assessment had been examined by an assessment workshop. It would have been helpful to have the authors of all the relevant documents available to make presentations and answer questions.

### B. Hogfish

#### 1. Assessment Report Recommendations

- a. Due to the relatively short time series and relatively low contrasts of CPUE for the available fishery data, the absolute historical limits of stock size and productivity are still somewhat unclear. This would suggest the need for further assessment analyses using other classes of modeling procedures like stock reduction analyses (Kimura et al. 1984), that could allow the merging of quantitative data time series with observations and opinions about historical states of the fishery.

#### 2. Review Workshop Research Recommendations

- a. Reef-fish commercial log-books should be considered as an additional source of data on commercial catch and effort.

- b. Weight data, as well as length, should be collected in the head-boat survey;
- c. Using data from spearfishing tournaments could reinforce length-weight relationships, especially at the right-hand end of the distribution where data are rare.
- d. The Review Panel considers it important to maintain the current data-collection programs.

### 3. Review Workshop Process and Procedure Recommendations

- a. The Review Panel observed that both it, and the presenters, had been handicapped in this review in that neither a data workshop, which would have verified the data sources, nor an assessment workshop had previously been held.

## C. Comments from CIE contractors

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

### 1. Process and Procedure Recommendations

- a. Some guiding documents that would have been useful were not provided. Notable among those were a) brief histories of the assessments, i.e. how they came into being, when, why, and at whose request they were written, and what the prospects would be of having changes made to them; and b) templates for reports—it transpired that the Advisory Report has a fairly specific format that is preferred, and a template or example would have been useful to clarify for the Chairman before the meeting how the information to be derived from the assessments was to be presented in final reports and therefore, to some extent, to define the set of information to be sought.
- b. A little more information on the meeting format would also have been helpful. The Chairman was not aware before the meeting that the public would be present, and when he was aware of it, he wasn't quite clearly informed what they were doing there and to what degree they were entitled to participate in the process. These questions got sorted out at the meeting, and in the end public participation was in high degree both orderly and helpful.
- c. Facilities for presenters were minimal and unsatisfactory: they needed more space to put their papers.
- d. It is a mistake to try to compress such meetings into too few days. Long days put unacceptable pressure on the report-drafting which ideally takes place at the meeting. We had a fairly uncomplicated and trouble-free meeting, but even so did not have much time to spare.
- e. The delayed response by some Panel members to reports has been a problem; when objections to decisions that were clearly nailed down at the meeting are first voiced two weeks later when the final report is about to be sent, an impossible situation arises in respect of completing and distributing the reports.
- f. The fact that the (hogfish) assessment had been conducted under contract also proved to be troublesome. The Review Panel was uncertain if the authors

could be asked to conduct sensitivity analyses given that they were no longer under contract. It was also unclear who would conduct any subsequent re-assessment.

- g. For both assessments, the stock area to be assessed was not clearly defined.
- h. In the report from the Goliath Grouper Data Workshop, distribution was discussed, but more in terms of distribution of the data rather than the species. This was a major issue of discussion for the Review Panel and the lack of a stock definition severely restricted the interpretation of results. For future assessments, this issue should be more closely examined at the Data workshop stage.
- i. The Peer Review Panel Reports included a section for Stakeholder Comments. This section, independent of and unedited by the Review Panel, provided meeting participants (other than the Review Panel) with a venue to express their views. Given the active participation of certain stakeholders during the workshop, I consider this to be an important and positive feature of these reports.

## **IX. SEDAR 7, Gulf of Mexico Red Snapper**

### **A. Data Workshop**

#### **1. Life History Group**

- a. More movement information via tagging is needed from the western Gulf. There was discussion that a recreational tagging data base from the Coastal Conservation Association (CCA) may be available for this purpose. The sub-group recommended every effort be made to access and analyze this data base (by LSU researchers).
- b. The results from the otolith micro-chemical analysis were compelling in providing estimates of mixing rates for the north-central, northwest, and southwestern Gulf. The sub-group recommends continued work to also derive mixing rates from the eastern Gulf (west Florida shelf). It was of great interest to determine if there was evidence for localized recruitment in the east or whether recruits were derived from other areas as suggested by tagging results.
- c. Much more otolith microchemistry needs to be conducted on snapper off Texas, especially age 0 & 1 cohorts to aid in our understanding of the recruitment dynamics there.
- d. There needs to be an examination of whether regional stock recruitment functions can be developed. It was recognized that trawl surveys, which have been previously relied upon for recruitment estimates, are conducted from Texas to the Florida/Alabama border and may not capture any localized recruitment which may occur on the west Florida Shelf. The sub-group recommended that other survey methods be examined for recruitment

determination and the red snapper larval index was recognized as a candidate for this purpose.

## 2. Shrimp Fishery Bycatch Group

- a. Future recommendations for improved data collection methods related to shrimp effort estimation include implementation of the Electronic Logbook Program (ELB) for 3-5 years (SEDAR7-REF-1; SEDAR7-REF-2) in conjunction with the current (or some form of) port agent interview system. Amendment 13 to the Shrimp Fishery Management Plan will address vessel monitoring systems (VMS) or ELB approaches for the shrimp fishery to obtain better effort data. Considerations of who will pay and own units (VMS or ELB) were discussed. VMS units are approximately \$1200 (+ monthly fee + maintenance) vs. ELB (\$500).
- b. The group strongly recommended a fully-funded shrimp trawl observer program to collect bycatch data as related to bycatch reporting requirements. This program would cost approximately \$2.5 KK annually.
- c. Work will continue on the new BRD designs using infrared observation technology (SEDAR7-DW-30). With this approach, we must encourage industry innovation by providing information to fishers for cooperative research to solve operational problems and maximize shrimp retention. The key to development of effective designs is getting new designs into the fleet, but this will result in innovation only if the industry has incentive to develop new technology. Consideration must also be given to the present certification protocol. BRD performance requirements will have to be re-examined based on performance projections of current BRD designs. BRD development should be focused on BRD designs which induce continuous and consistent bycatch escapement during variable environmental and commercial applications.

## B. Assessment Workshop

- a. direct measurement of current fishing mortality rates,
- b. experiments to determine the magnitude and timing of density dependent compensation in juveniles,
- c. information on the effects on shrimp trawling on red snapper through community effects including nutrient cycling and changes in predation pressure,
- d. continuation and expansion of the fishery-independent survey for adult red snapper,
- e. more information on release mortality and discard rate by depth, season, and fishery,
- f. additional alternatives for reducing bycatch such as closed areas etc.,
- g. additional research such as simulation testing on the estimation properties of stock assessment methods and models,
- h. distribution and mixing between the East and West.

### C. Review Workshop

Some of the following research recommendations are marked [D] or [A] or both. The symbol indicates that all or part of the corresponding recommendation was adapted from recommendations of the SEDAR 7 Data Workshop or Assessment Workshop.

- a. *Data on shrimp fishery.* The RW recognized the importance of obtaining better estimates of fishing effort in the shrimp fishery, which might be done through vessel monitoring systems, electronic logbooks, or otherwise [A]. Also, the RW recommends that the statistical design and extent of the shrimp-trawl observer program be reviewed to ensure that the bycatch data collected are appropriate and sufficient for stock assessment.
- b. *Independent estimates of mortality rates.* Direct estimation of mortality rates through tagging would reduce uncertainty in future assessments [A].
- c. *Fishing power.* Research is recommended to estimate (independently of any stock assessment) changes in catchability  $q$  by gear over time. The RW believes that the introduction of GPS and marine chart-plotting equipment is likely to have increased fishing power substantially for some modes of fishing. Independent collection of data on fishing effort would provide valuable data for assessment and relieve the need to estimate catchability changes.
- d. *Stock structure.* Research (e.g., tagging, otolith analysis) is recommended to better describe stock structure and mixing rates. Research should include a review of oceanographic data to see whether transport from the Campeche Banks could reasonably be supplying important numbers of larvae to the western Gulf stock [A].
- e. *Spawning-stock index.* Given the many factors that can mask relationship of larvae to spawners, the value of the larval indices should be reviewed.
- f. *Spatial distribution at age.* The RW recommends study of the age structure observed from longlines (survey and fishery), to clarify geographic distribution of fish as they age.
- g. *Density dependence.* Research could clarify the magnitude and timing of density dependent compensation in juveniles by estimating survival (from age-0 to age-1 year) at different densities of juvenile abundance [A].
- h. *Ecosystem concerns.* The RW recommends that the management objectives for the fishery complex (shrimp, red snapper, vermilion snapper, etc.) be formalized. Simulation studies could usefully identify and evaluate appropriate management strategies (including use of various reference points) and corresponding assessment modeling approaches. Research could also test the hypothesis that red snapper production is enhanced in some way by increased shrimp trawling [A].
- i. *Assessment modeling.* The RW's recommendations for assessment modeling are made while recognizing that technology is currently limiting (the power of current small computers is marginal for the given model complexity). (a) Future assessments should include interval estimates on parameters and status indicators. (b) More diagnostic and output information should be provided in

future assessment reports (e.g., plots or tables of  $F$  at age and plots of standardized residuals). (c) Extensive simulation tests of assessment models are recommended to examine accuracy, precision, and robustness [A].

- j. *Age sampling*. The RW recommends that representative sampling of age- and length-composition of red snapper be conducted consistently across area, time, and gear.
- k. *Fecundity at age*. The RW noted that few fecundity samples were available from older fish, and recommends that more such samples be collected.
- l. *Model implementation*. The RW recommends that the assessment model's recruitment sub-model be generalized to allow various options on the timing of bycatch mortality relative to density dependent compensation (see AW-8).